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confinement, when they were separated. After 89 hours the female was killed, the remainder of her eggs placed on glass slides, and fertilized with a decoction of the testes of other (one or more?) males. If many of the eggs soon rotated within their membranes this was taken as a sign of successful fertilization. It will be noted that a different male from that employed for the normal fertilization was necessarily employed, because the original male had presumably lost his power to further fertilize. The employment of different males introduces a possible error into the results, for, if the male is heterozygous for sex determination, it is conceivable, as I have previously pointed out in reviewing Hertwig's results, that in different individuals the sperm may be differently affected in regard to its fertilization power. At present we have no evidence to show that in male frogs such differences exist, and it seems unlikely that such consistent results as these of Hertwig and of Kuschakewitsch can be explained in this way. An alternative view is, however, possible. If the female is heterozygous for sex production, and in consequence two kinds of eggs are produced, it may be that the female determining eggs are more injured by delay than are those of the other class, the male-determining eggs. It becomes, therefore, imperative to know what proportion of eggs were fertilized in these experiments. Unfortunately this critical evidence is omitted from Kuschakewitsch's paper. He states that the death rate of the tadpoles that emerge is low, but one looks in vain for information relating to the number of eggs that were fertilized. Therefore until this datum is forthcoming it is not possible to draw any certain conclusions in regard to sex determination from the evidence published by the author.

T. H. MORGAN.

COLUMBIA UNIVERSITY.

THE MUTATION THEORY

The publication of the first volume of DeVries's "*Mutations-theorie*" in 1901, together with the rediscovery of Mendel's principles, served to bring about a period of unprecedented activity in the study of the problems connected with variation, heredity and evolution. While the results of this decade of work have probably raised as many questions as they have answered, yet the period has undoubtedly been marked by advances of the first importance, both in methods of investigation and in

results and the point of view achieved. This stimulus we owe in no small measure to the author of "Die Mutationstheorie." During this period DeVries himself has continued his activities uninterrupted except by his two visits to America, in which he did much through his letters and the publication of his "Species and Varieties" and "Plant Breeding," to familiarize his views to American biologists. However, the actual detailed data upon which his theory was based, remained largely a sealed book except to readers of German. Even those engaged in active work on these subjects frequently failed to acquaint themselves sufficiently with "Die Mutationstheorie" before breaking into the field of controversy. Particularly is this true of the second volume, the contents of which have been in large part neglected.

Professor Farmer and Mr. Darbishire have therefore performed an important service in translating this work into English. The first volume of their translation¹ is the subject of this review. The second volume is promised for April. The work will undoubtedly receive a wide reading by English-speaking biologists, and by others as well. The translation is an excellent one, faithful to the German meaning but rendered into idiomatic English. Whatever the degree of one's familiarity with the German edition, a perusal of the work in English will be found profitable and stimulating.

A few remarks regarding the contents of the book itself may not be out of place. In a re-perusal of the work, one is struck with the optimism of its author and with the brilliancy and breadth of his exposition of the views set forth. It is not necessary to agree with these views in their entirety in order to appreciate these qualities of the book. The analysis of the data amassed by Darwin, in which it is shown that Darwin's *single variations* are the same as De Vries's mutations, seems to the reviewer particularly effective. The conception of elementary species seems also one which will be of lasting value, having already shed a flood of light on many problems.

Probably the time will soon come when nearly all biologists will be ready to admit that mutation, or the sudden appearance of new forms, has been an important factor at least, in species formation in plants and animals. Admitting this, it remains to be discovered what relation these sudden appearances bear to the gen-

¹ DeVries, Hugo, 1909, "The Mutation Theory." Translated by Professor J. B. Farmer and A. D. Darbishire. Volume I. Six colored plates, figs. 119, pp. 582. Chicago, The Open Court Publishing Co.

eral trends of evolution, which are apparent in so many phylogenies. This larger problem, which may not be amenable to direct experimental attack, will probably occupy evolutionists for many years to come. For, granting the facts of mutation, we have only accounted for a micro-evolution, and it has still to be shown that the larger tendencies can be sufficiently accounted for by the same means, without the intervention of other factors.

While the supreme importance of DeVries's investigations on mutation in *Oenothera* is fully recognized, his premutation theory has always seemed to the reviewer unsatisfactory as a hypothesis to explain the material basis of these phenomena. The cytological investigations of myself and others on these forms have determined the events of germ cell formation, some of which provide a possible basis for the sudden appearance of new types. They have, moreover, shown that different cytological processes are involved in the origin of different mutants, and in this way have thrown much light on the relationships of some of the mutants to their parent form. It is probable that the whole question of the relation of the mutants to their parent will be found to be much more complex than at present supposed.

R. R. GATES.